

The Unmanned Aircraft Systems Program: Ongoing Activities in Support of NOAA Priorities



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NOAA UAS Program





NOAA UAS Program Vision and Key Roles



- ***Vision***
 - UAS observations will become an essential component of the NOAA observing system
- ***Key Roles***
 - Serve as the NOAA subject matter experts for UAS technology and observations
 - Assist with the research, development, demonstration and transition to application of select UAS observing strategies





Critical Elements Needed to Mature a Complete Observing Strategy





Project Selection

Project Sources

- Internal solicited or unsolicited proposals from NOAA scientists and cooperative institutes
- Federal agency partnership opportunities
- Cost sharing commitments to projects proposed to other federal agencies
- Small Business Innovation Research (SBIR) program
- Private industry Cooperative Research and Development Agreements (CRADAs)
- Specific congressional directives (e.g. Disaster Recovery Act of 2013)

Selection Criteria

- Importance and relevance to NOAA mission
- Scientific merit
- Technology readiness and likelihood for transition
- Qualifications of project team
- Cost and cost sharing
- Project risk and mitigation plan
- Partnership opportunities
- Portfolio balance between mature, low risk concepts and high risk / high reward concepts



UAS Program Science Focus Areas



High Impact Weather

- *Can UAS observations enable improved forecasts, scientific understanding and decision support?*



Marine

- *Can UAS observations provide reliable, timely and affordable environmental intelligence information for resilient coastal communities and healthy oceans?*



Polar

- *Can UAS observations contribute to NOAA'S Arctic vision and strategy?*

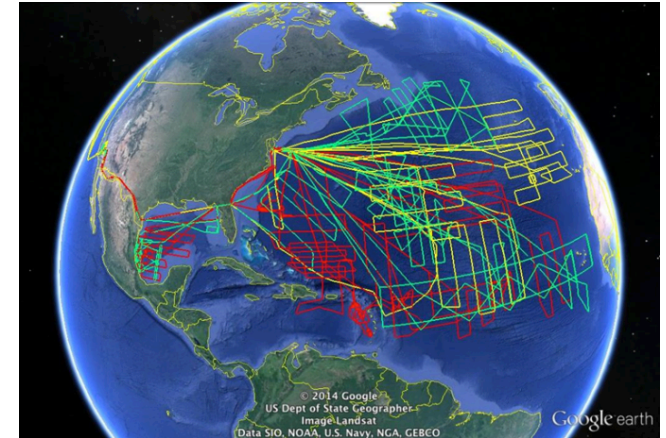


Sensing Hazards with Operational Unmanned Technology (SHOUT)



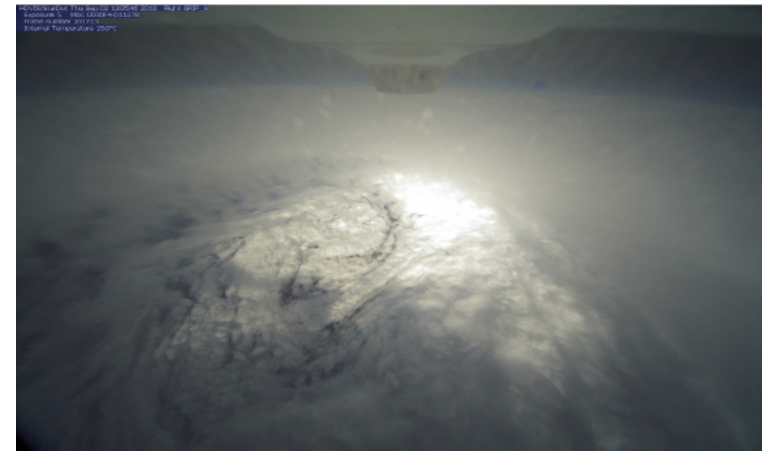
Objective

- **Demonstrate and test prototype UAS concept of operations that could be used to mitigate the risk of diminished high impact weather forecasts and warnings in the case of polar-orbiting satellite observing gap**
 - Data impact studies
 - Cost and operational benefit



Demonstrations

- **Global Hawk aircraft**
- **2014: Collaboration with NASA Hurricanes and Severe Storms Sentinel (HS3)**
- **2015: Hurricanes and tropical cyclones**
- **2016: Arctic/Pacific high-impact weather**



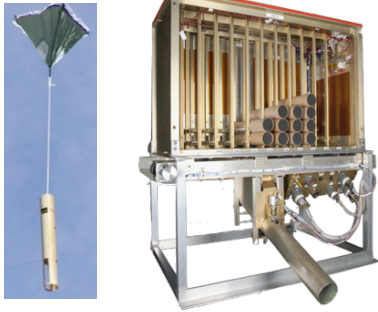


SHOUT 2015

Global Hawk Instrumentation



Airborne Vertical Atmospheric Profiling System (AVAPS)



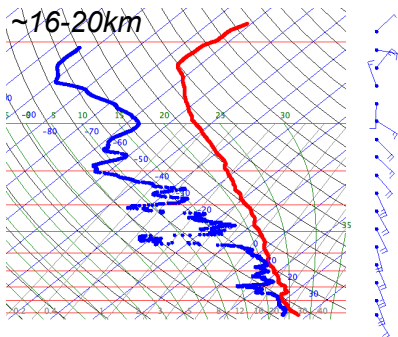
PI: Terry Hock, NCAR / Gary Wick, NOAA

Measurements:

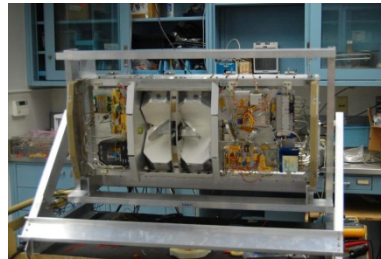
- temperature, pressure, wind, humidity (vertical profiles);
- 88 dropsondes per flight;

Resolution:

- ~2.5 m (winds), ~5 m (PTH)



High Altitude Monolithic Microwave Integrated Circuit (MMIC) Sounding Radiometer (HAMSR)



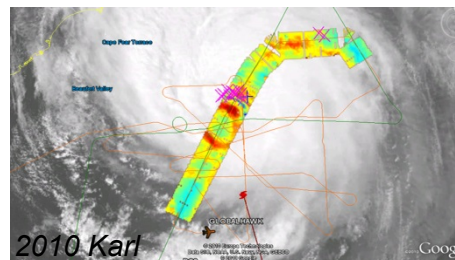
PI: Dr. Bjorn Lambrigtsen, JPL

Measurements:

- Microwave AMSU-like sounder;
- 25 spectral channels in 3 bands; (50-60 GHz, 118 GHz, and 183 GHz)
- 3-D distribution of temperature, water vapor, & cloud liquid water;

Resolution:

- 2 km vertical; 2 km horizontal (nadir)
- 40 km wide swath



High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP)



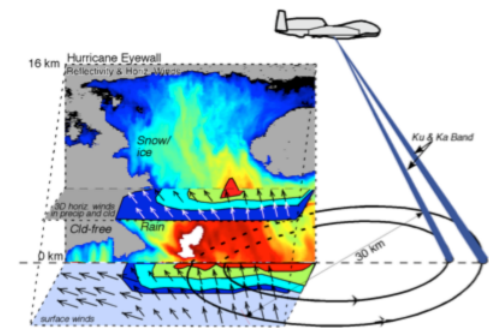
PI: Dr. Gerald Heymsfield, NASA GSFC

Measurements:

- Dual-frequency (Ka- & Ku-band), dual beam, conical scanning Doppler radar
- 3-D winds, ocean vector winds, and precipitation;

Resolution:

- 60 m vertical, 1 km horizontal;

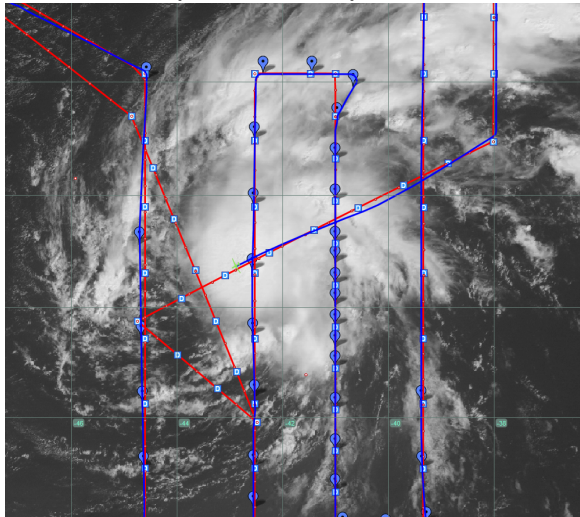




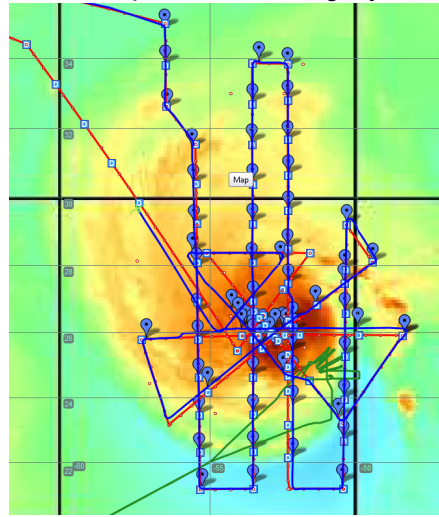
Global Hawk Sampling of Edouard



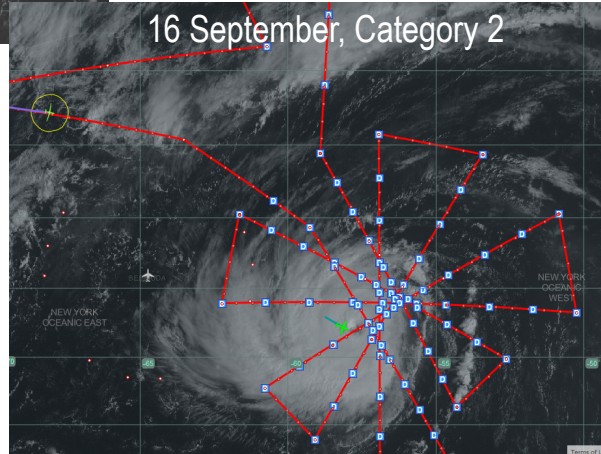
11 September, Tropical Storm



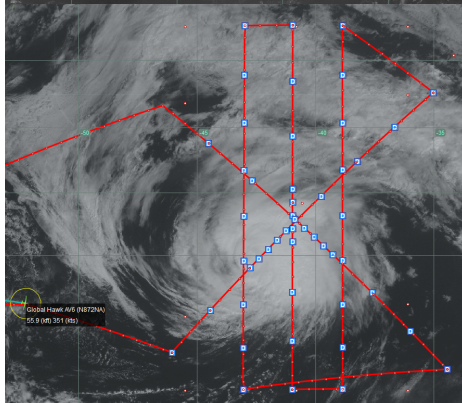
14 September, Category 1



16 September, Category 2



18 September, Decay



- **282 total dropsondes deployed during more than 58 hours around storm**
- **Complete life cycle sampled**
- **Key data suggesting rapid intensification on 15 September**
- **Data processed in real time and, transmitted to NWS gateway**



SHOUT Data Impact Assessment



- **Preliminary hurricane data impact assessment released**
- **Comprehensive assessment team funded**
 - Observing system simulation experiments (OSSE)
 - Observing system experiments (OSE)
 - Process studies
- **Initial results suggest UAS observations can positively impact forecasts and provide critical real-time guidance**

**SENSING HAZARDS WITH
OPERATIONAL
UNMANNED
TECHNOLOGY (SHOUT)
TO MITIGATE THE RISK
OF SATELLITE
OBSERVING GAPS**

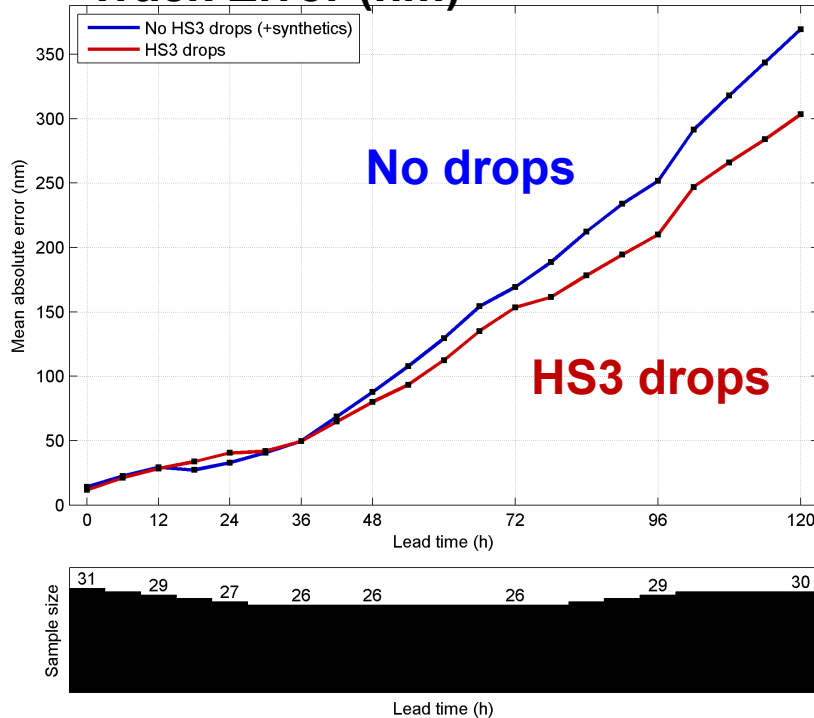
First Report - A
Preliminary Impact
Study of Global Hawk
Unmanned Aircraft
System (UAS)
Observations for
Hurricane Forecasting

Lead Author: G. A. Wick

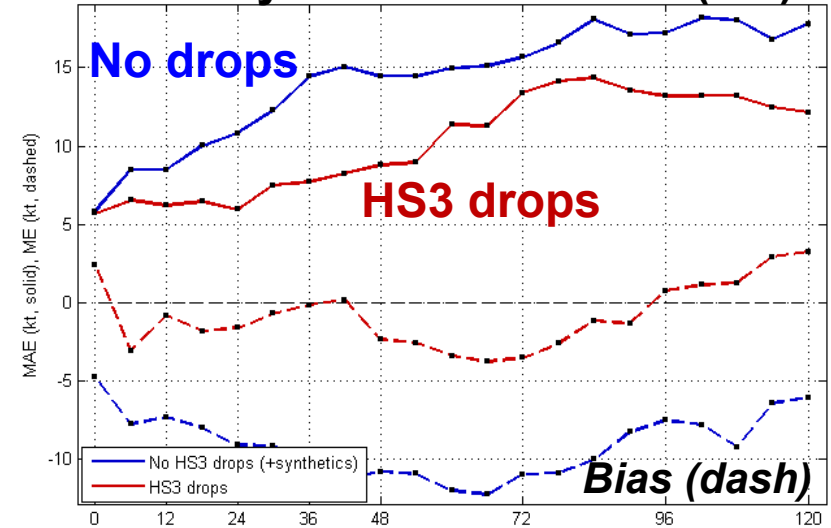
31 December 2014

Impact of HS3 Dropsondes for Navy COAMPS-TC Hurricane Nadine Predictions

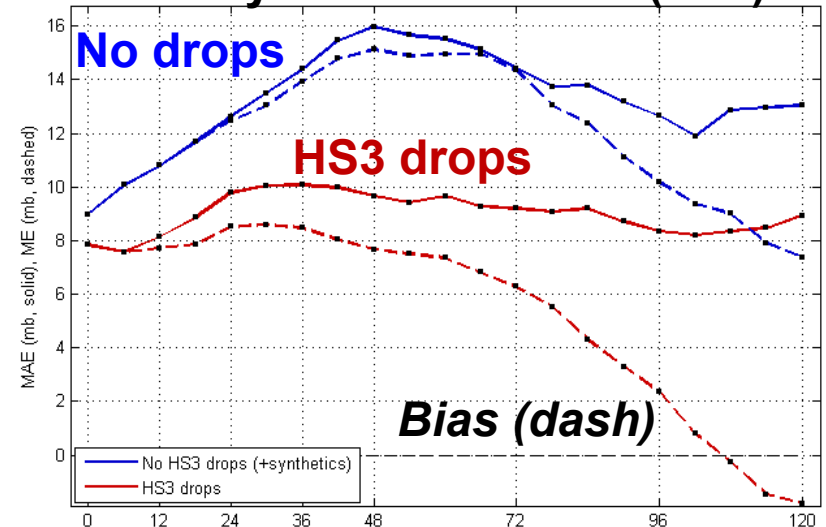
Track Error (nm)



Intensity: Max. Wind Error (kts)



Intensity: Min. SLP Error (hPa)

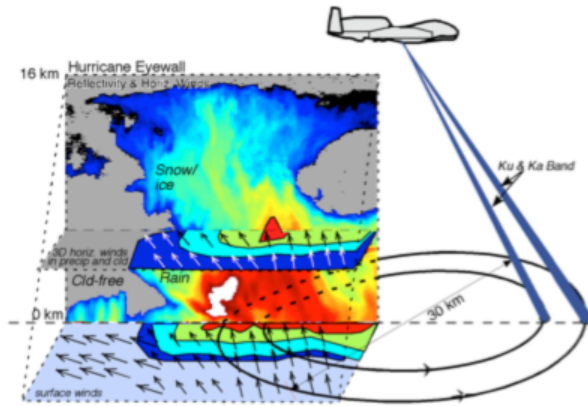
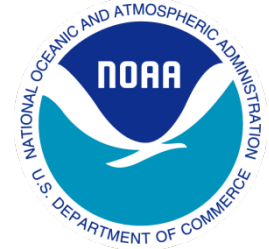


- Dropsonde impact experiments performed for 19-28 Sep. (3 flights)
 - Red: with HS3 drops
 - Blue: No drops with synthetics
- COAMPS-TC Intensity and Track skill are improved greatly through assimilation of HS3 Drops.

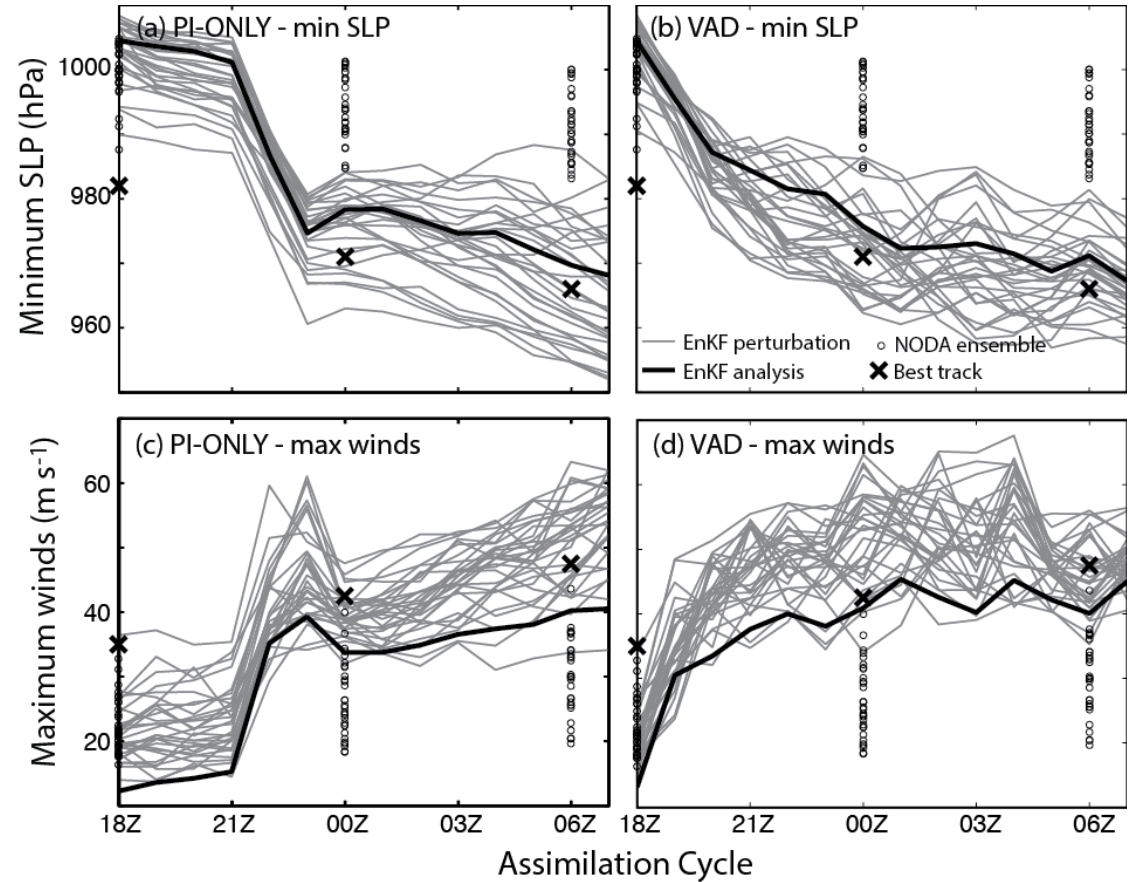
Slide courtesy of James Doyle / NRL



HIWRAP Impact



Courtesy Gerald Heymsfield,
NASA GSFC



From Sippel et al., 2014



Support for River Forecasting



Objective

- Support River Forecast Centers through high-resolution monitoring of remote river basins
 - Detailed land/water maps
 - Digital elevation maps
 - Flow estimates

Demonstrations

- Sampling of Pearl River Basin with Puma and Altavian aircraft



Summer



Winter



Collaboration with NOAA Fisheries



- **Participating in many collaborative experiments demonstrating capabilities of small UAS to monitor:**
 - Fish
 - Marine mammals
 - Sea birds
- **Facilitates mandated surveys and species counts in remote and hazardous regions**
- **Platforms include small fixed-wing and vertical take off and landing (VTOL) aircraft**

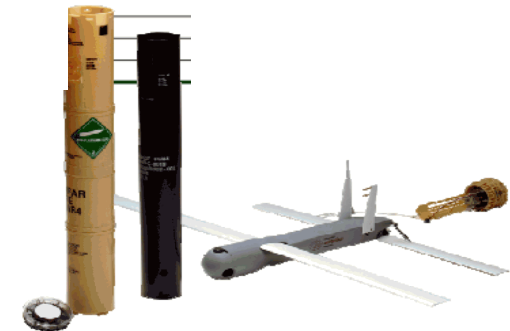




Emerging Activities

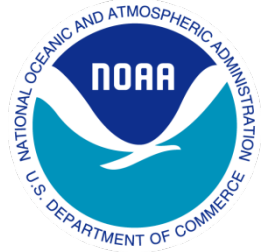


- **Program review facilitated NOAA stakeholder guidance on priorities**
- **Receiving multiple calls from within agency pursuing collaboration**
- **Major common theme is boundary layer research**
 - **Convective storms and convective initiation**
 - **Hurricane boundary layer**
- **Anticipating proposal call in 2016**
- **Disaster response additional priority**





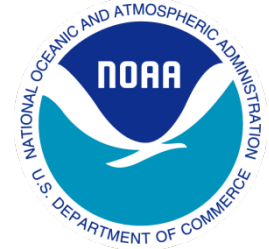
Backup Slides



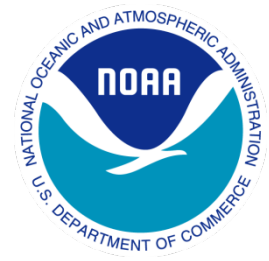
Program Influences and Priorities



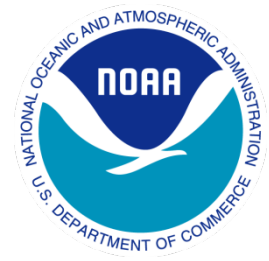
Motivating Factors for Unmanned Aircraft Systems (UAS)



What Missions?	What Benefits?	Why Now?
<ul style="list-style-type: none">• <i>Dull</i>• <i>Dirty</i>• <i>Dangerous</i>• <i>Remote</i>	<ul style="list-style-type: none">• <i>Very high altitudes</i>• <i>Long endurance</i>• <i>Long range</i>• <i>Very low altitudes</i>• <i>Quiet</i>• <i>Rapid response potential</i>	<ul style="list-style-type: none">• <i>Improving flight performance</i>• <i>Increasing payload options</i>• <i>Improving affordability</i>• <i>In preparation for increasing access to airspace</i>



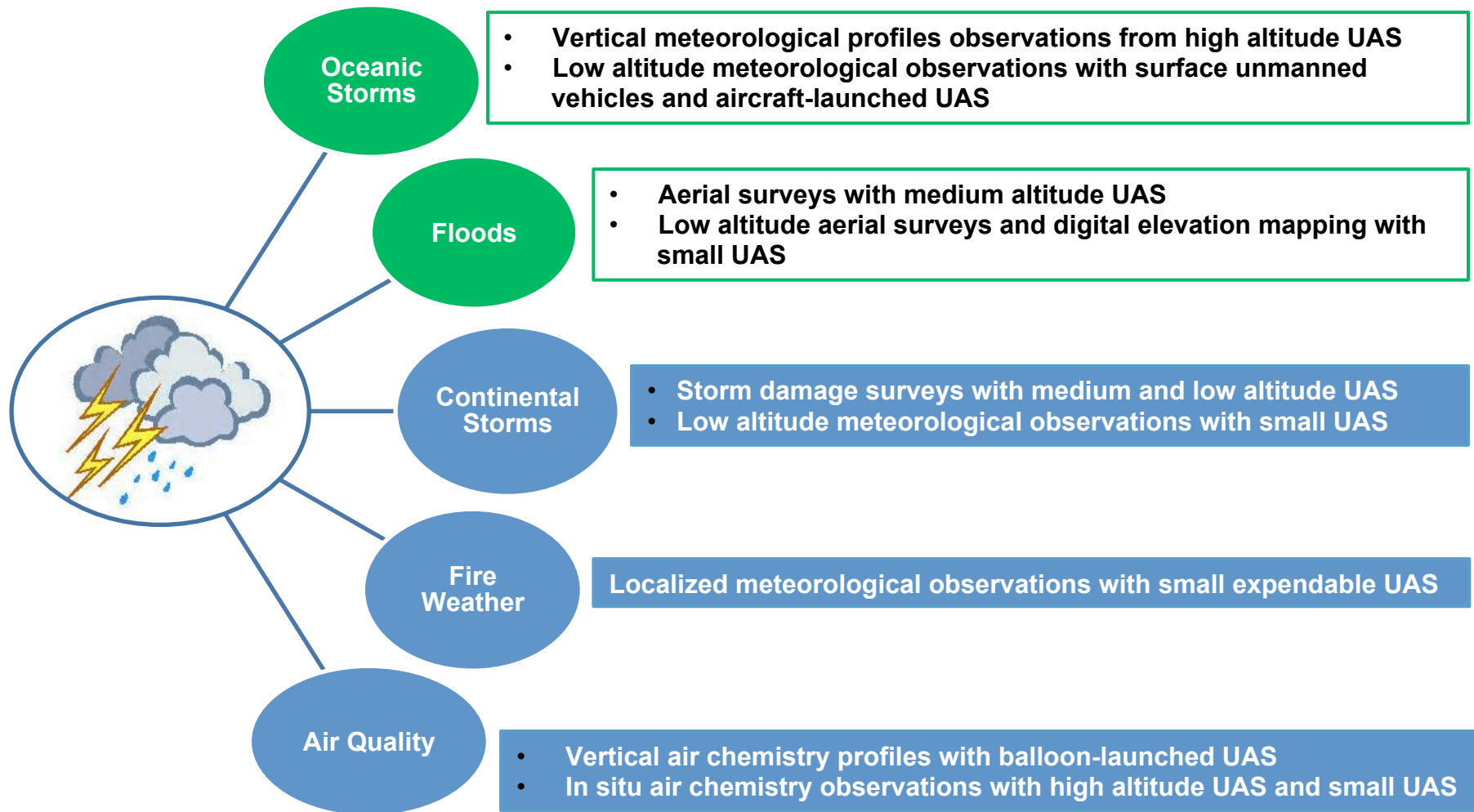
Demonstration Highlights



Future Plans

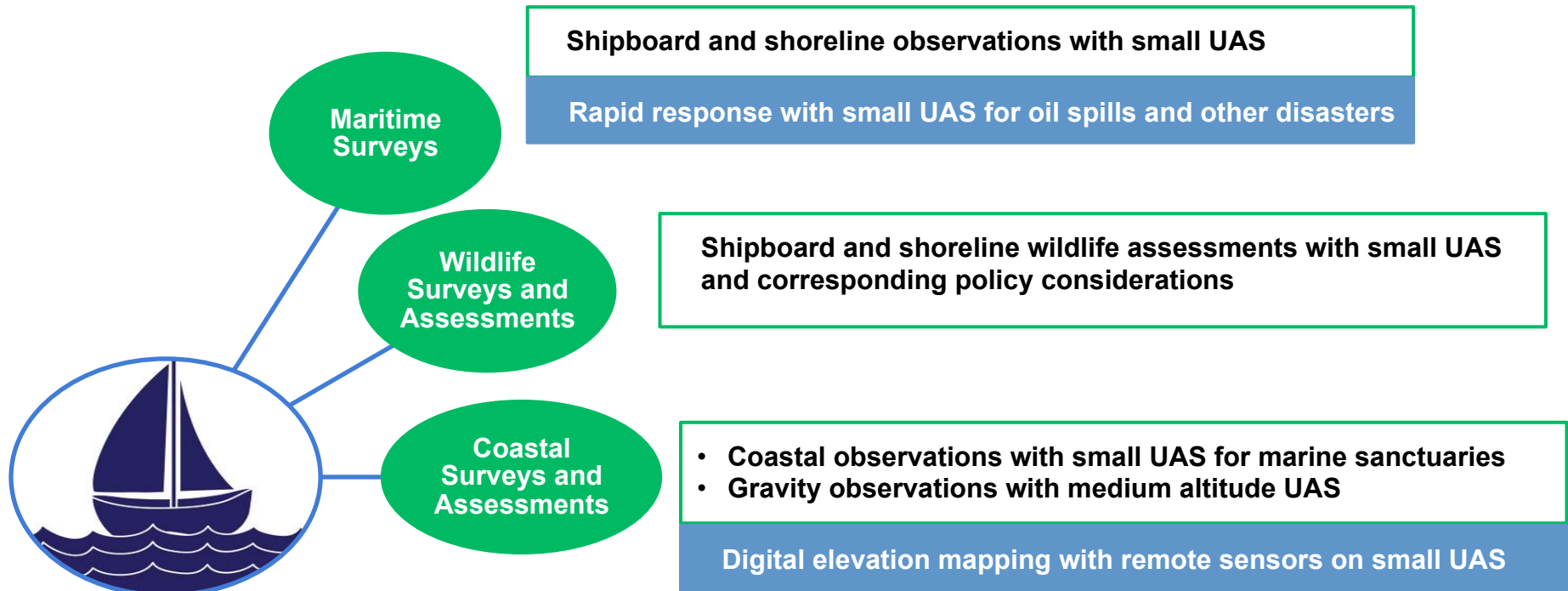


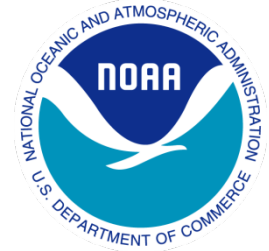
Next Steps – High Impact Weather



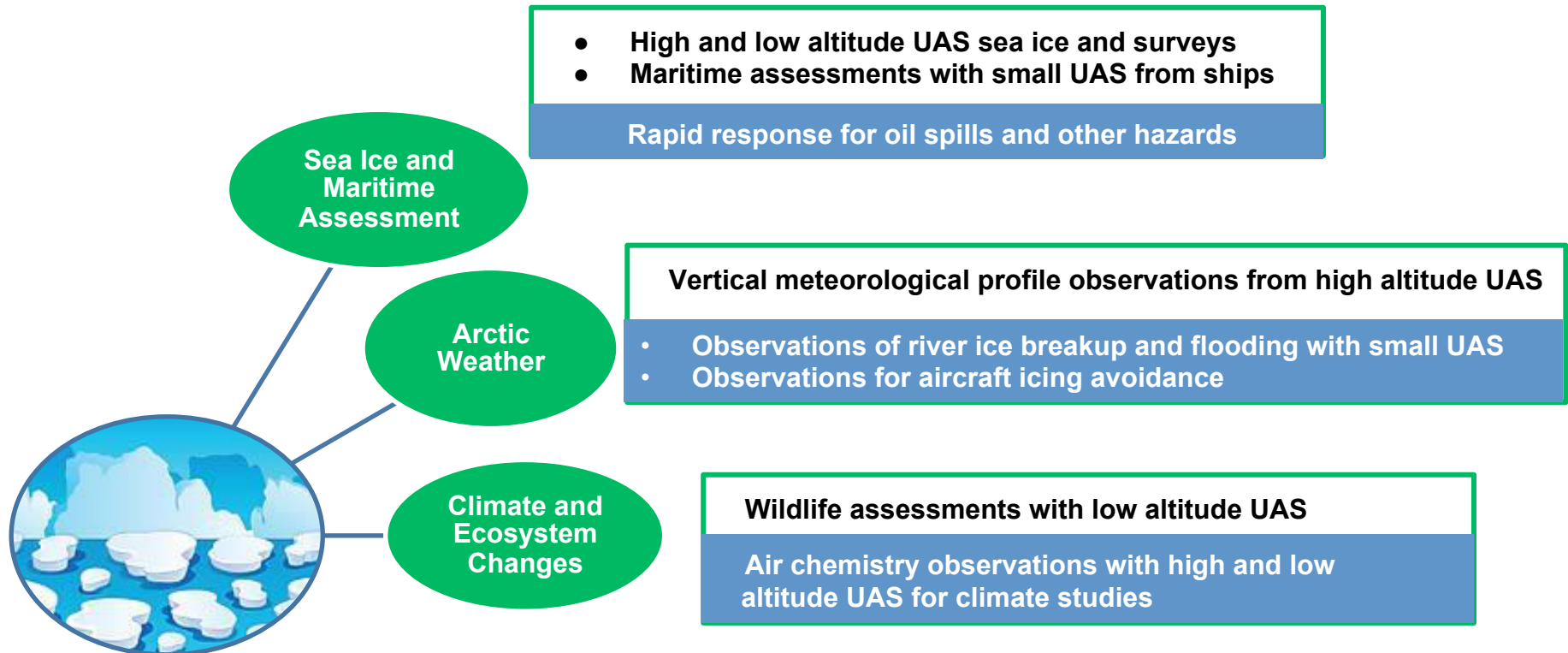


Next Steps – Marine Observations





Next Steps – Polar Observations









Concluding Remarks



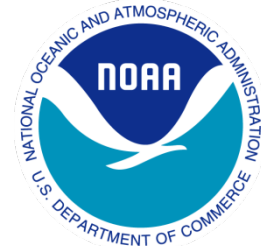
Observing Strategies by Fixed Wing UAS Capabilities and Science Focus Area








UAS Platform	High Impact Weather	Marine	Polar
HALE 	RESEARCH Oceanic storm vertical meteorological profiles Ocean storm surface winds / rain High altitude air quality		DEVELOPMENT Arctic weather vertical meteorological profiles Arctic high altitude air quality RESEARCH Sea Ice surveys
MALE 	DEMONSTRATION Flood aerial surveys RESEARCH Continental storm damage assessment -	DEMONSTRATION Maritime enforcement surveys Wildlife surveys RESEARCH Coastal gravity observations	RESEARCH Flood aerial surveys
LALE 	RESEARCH Continental storm in situ observations Continental storm damage assessment	RESEARCH Wildlife assessments	DEMONSTRATION Sea ice surveys Arctic weather in situ observations Arctic in situ air quality DEVELOPMENT Arctic icing weather observations Wildlife assessments
LASE 	DEMONSTRATION Flood aerial surveys DEVELOPMENT Flood digital elevation mapping Continental storm in situ observations RESEARCH Continental storm damage assessment	DEMONSTRATION Maritime enforcement surveys Maritime oil spill aerial surveys Maritime oil spill response imagery Marine debris response imagery Wildlife aerial surveys RESEARCH Coastal digital elevation mapping	DEMONSTRATION Sea ice aerial surveys for ships Arctic oil spill aerial surveys



Observing Strategies by Other Unmanned Capabilities and Science Focus Area



UAS Platform	High Impact Weather	Marine	Polar
VTOL 	RESEARCH Continental storms in situ meteorological observations Air quality in situ observations	DEMONSTRATION Maritime oil spill response imagery Wildlife assessments	DEMONSTRATION Wildlife assessments
ACL 	DEMONSTRATION Oceanic storm low altitude in situ meteorological observations		
BL 	DEMONSTRATION Air quality vertical profiles		RESEARCH Arctic air quality vertical profiles
SMUV 	DEVELOPMENT Oceanic storm low altitude in situ meteorological observations	DEVELOPMENT Maritime assessments Wildlife assessments Coastal assessments	
TB 		RESEARCH Maritime assessments	RESEARCH Arctic maritime assessments